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BREEDING BIOLOGY AND NEST CHARACTERISTICS OF THE WHITE-THROATED HAWK (*BUTEO ALBIGULA*) IN NORTHWESTERN ARGENTINE PATAGONIA

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ABSTRACT.—We studied the breeding biology of the White-throated Hawk (*Buteo albigula*) in *Nothofagus* forests of northwestern Argentine Patagonia. We documented 11 nesting attempts from September to April 1998–2002, and recorded behavioral observations at two nests during the 2001–02 breeding season. After the hawks' arrival in the area in mid-September, the pre-laying period extended approximately until early November (ca. 1.5 mo). Laying at two nests occurred between 10 and 15 November. Incubation lasted until 15–17 December (ca. 1 mo). The brood rearing period (ca. 40 d) extended until late January, when fledging was observed. However, in one nest in the 2000–01 season, we found a small chick on 13 January that fledged about 20 February, which suggests that some late breeding attempts can be successful. Females performed most of the incubation. Pairs produced only one fledging per successful nest, but we observed two nestlings during the early brood-rearing stage at one nest. Both sexes defended nests against intruders. Males delivered all of prey brought to the nests during incubation, and 80% of food delivered during the nestling period. Birds, rodents, and lizards were the most numerous prey brought to nests. White-throated Hawk nests were platforms made of dry and green sticks located at a mean height of 16 m above the ground in *Nothofagus* trees that averaged 0.8 m in diameter at breast height.

KEY WORDS: *White-throated Hawk*; Buteo albigula; *breeding biology*; *nests*; *northwestern Patagonia*; *Argentina.*

BIOLOGÍA REPRODUCTIVA Y CARACTERÍSTICAS DE LOS SITIOS DE NIDIFICACIÓN DEL AGUILUCHO ANDINO (*BUTEO ALBIGULA*) EN EL NOROESTE DE LA PATAGONIA ARGENTINA

RESUMEN.—Estudiamos la biología reproductiva del aguilucho andino (*Buteo albigula*) en bosques de *Nothofagus* del noroeste de la Patagonia argentina. Documentamos 11 intentos de nidificación desde septiembre a abril de 1998–2002, y registramos observaciones de comportamiento en dos nidos durante la estación de cría 2001–02. Luego de la llegada de los aguiluchos al área a mediados de septiembre, el período previo a la postura se extendió hasta principios de noviembre (aproximadamente un mes y

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medio). La postura en 2 nidos tuvo lugar entre el 10 y el 15 de noviembre. La incubación se prolongó hasta el 15–17 de diciembre (alrededor de un mes). El período de crianza en el nido se extendió hasta fines de enero, cuando los volantones abandonaron el nido (aproximadamente a los 40 días de edad). Sin embargo, en uno de los nidos durante la temporada reproductiva 2000–01, encontramos un pichón el 13 de enero que voló aproximadamente el 20 de febrero, lo que sugiere que la reproducción puede retrasarse ocasionalmente con éxito. Las hembras llevaron a cabo la mayor parte de la incubación. Las parejas produjeron sólo un volantón por nido exitoso, aunque en uno de los nidos observamos dos pichones al comienzo del período de crianza. Ambos sexos defendieron los nidos contra los intrusos. Los machos aportaron el 100% de las presas durante la incubación, y el 80% durante el período de crianza en el nido. Las presas llevadas a los nidos fueron principalmente aves, roedores y lagartijas. Los nidos del aguilucho andino se encontraban en promedio a 16 m sobre el terreno en árboles de *Nothofagus* de 0.8 m de diámetro a la altura del pecho. Todos los nidos eran plataformas construidas con ramas secas y verdes.

[Traducción de los autores]

Among Neotropical birds, raptors are one of the least studied groups and relatively little is known about their breeding biology (Bierregaard 1998). The White-throated Hawk (*Buteo albigula*) is distributed along the Andes, ranging from southern Argentina and Chile to Bolivia, Peru, Ecuador, Venezuela, and Colombia (del Hoyo et al. 1994). In Argentina, this hawk inhabits the southern beech (*Nothofagus* spp.) forests of western Patagonia (40°02′S–42°51′S; Gelain et al. 2001), and the northwestern part of the country (Olrog 1979, Canevari et al. 1991). Little is known about the biology of the White-throated Hawk. Pavez (2000) recorded migratory movements of White-throated Hawk flocks from south to north in autumn (March–May) and from north to south in the spring (September–October) in central Chile. Recently, breeding pairs were located in northwestern Patagonia, from early September through early April (Gelain et al. 2001), and first description of nests were published (Trejo et al. 2001). Also Figueroa et al. (2001) described movements and hunting strategies of hawks in southern Chile. Our study summarizes information on breeding biology, behavior, and nests of this forest raptor collected during 4 yr in northwestern Argentine Patagonia.

METHODS

We studied White-throated Hawks in the vicinity of Bariloche city (41°08′S, 71°12′W), northwestern Argentine Patagonia. Physiographically, the area consists of lakes, glacial valleys, and mountain slopes covered by forests dominated by southern beech. Elevation ranges from 400–3480 m. Mean annual temperature is 8°C and total annual rainfall ranges from 500–2000 mm, mainly concentrated in winter (Paruelo et al. 1998). Predominant winds come from the west.

We conducted fieldwork during four breeding seasons (September–April 1998–2001) in four nesting territories used by breeding pairs in consecutive years. For a general description of these sites, see Gelain et al. (2001) Throughout breeding season, we (at least once a week) made periodic visits and recorded the activities of territorial pairs. Early-season observations were made from vantage points to determine the probable locations of nests. We located occupied nests by following adults carrying nest material or food, and by noting the aggressive diving behavior of one or both members of the pair when we approached the nest site. Thereafter, we visited the nests every 1–2 wk (sometimes more often), and recorded activities and behavior observed. Binoculars and a 20–60× spotting scope were used throughout the study.

We defined a nest as occupied when it contained young or when an adult was seen in the nest incubating. We classified a nest as successful if at least one young was fledged.

We observed the hawks' daily routine in two nests (N1 and N2) throughout the 2001–02 breeding season (15 November 2001–24 January 2002). These two nests were located in the Challhuaco River Valley, 15 km southeast of Bariloche. This is a rugged area covered by 1900 ha of pure old-growth deciduous lenga (*Nothofagus pumilio*) forest averaging 15 m tall, located at 900–1650 m above sea level. The understory is open, dominated by small bushes (primarily *Ribes magellanicum, Berberis serratodentata, Schinus patagonicus*), and annual herbs (*Alstroemeria aurea* was most common). Observations at these two nests were carried out once a week, and were made from dawn to dusk (0600–2100 H). We monitored the nests from 29 November–27 January (2 wk during incubation and 5 wk during the brood-rearing period) for a total of 210 hr. Observations were made from ground blinds at distances of 20–25 m from the nest tree.

For both adults at each nest we recorded the birds' activity, time and duration of the activity, and a description of any associated behavior. We classified behaviors into the following categories: incubating, attending nest, feeding young, in vicinity, and absent. The "attending nest" category included the perching, preening, stretching, resting, feeding, adding nest material, or anything else, but not incubating or feeding nestlings. "In vicinity" refers to the amount of time an adult was perching in the nesting territory, or flying from perch to perch, or was present in the nest neighborhood (included visual and vocal detections). Activities 20–30 m away from the

nest could not always be seen clearly due to the presence of a dense canopy. All prey items delivered to the nest were identified to Class or Order whenever possible. Daily feeding rates were calculated excluding days when no feeding events were observed. Twigs carried to the nest were classified as green or dry, based on the presence/absence of leaves.

We marked one adult of each pair monitored during 2001–2002 breeding season. Shortly after nests were located, we trapped one male with the aid of a bal-chatri trap baited with a hamster, and one female with a dhogaza net and a stuffed Magellan Horned Owl (*Bubo magellanicus*) (Bloom 1987). Birds were ringed with uniquely-numbered aluminum bands. Gender of captured hawks was determined by size comparison and behavior (e.g., incubation).

After young fledged or the nest failed, we climbed to the nest trees to describe and measure the platforms. We recorded the following microhabitat variables: nest-tree species, nest-tree height (with an optical range finder), nest-tree diameter at breast height (DBH, with diameter tape), nest tree condition (live, partly dead, or dead), nest height (measured in plumb-line distance from the nest to ground level using a measuring tape), distance from the inner edge of the nest to the main axis of the nest tree, and nest compass orientation relative to that tree axis (deviation from magnetic north grouped in 45° octants). We also measured elevation with an altimeter, slope (%) with a clinometer, and compass aspect of the nest sites. Distance between occupied nests was only estimated (using Global Positioning System, [GPS] coordinates and receiver) for N1 and N2, the only breeding territories that were likely adjacent.

RESULTS

We located one occupied nest in 1998, one in 1999, four in 2000, and five in 2001 (including one renesting attempt) in the four nesting territories. Eight of the 11 occupied nests (72%) were successful and all fledged one young.

Two nests were located at the pre-laying stage, six at the incubation stage, and three during the brood-rearing period.

Pre-laying Period. The pre-laying period extended approximately from mid-September until early November (ca. 1.5 mo). The pairs were observed around their nesting territories in early October, when one or both adults flew by us in a non-aggressive manner, generally responding to play-back calls and then flying off. Closer to laying date, birds usually became very attached to the nest site, but still showed no aggressiveness. Behaviors observed in this period were undulating-flight displays, copulations, and nest-building activities. Six undulating displays were observed (12 October–29 November) during the pre-laying period and early incubation, in different pairs/seasons, all performed by the male in the presence of the female (except one). Nest-building activities, which were recorded only twice during this period, continued throughout the incubation and brood-rearing stages, when they increased noticeably.

We witnessed eight copulations of five different pairs/seasons, between 17 October and 17 November. These always took place on dead trees or dead branches adjacent to nest trees. Copulations were not preceded by any discernible courtship behavior except vocalizations from both members of the pair. Once, copulation followed a territorial defense by the pair against a Red-backed Hawk (*Buteo polyosoma*).

Incubation Period. We observed incubation activities at six nests. One of these nests failed, leaving an egg which measured 50.23 × 39.98 mm, was white, without gloss or spots, only showing some brownish stains (Fig. 1). Egg fragments found at another nest were also totally white and without gloss on the outer side, and bluish inside.

At N1 and N2, laying was initiated about 10–15 November, and incubation continued until 15–17 December (ca. 1 mo). During our daily observations at N1 and N2 during 2 wk, most of daytime incubation was done by the female, but we recorded some incubation by the male (Table 1). During daytime both members of the pair took turns at incubating. The male's shifts varied from 13 min–2 hr 30 min, and averaged 57 min ($N = 7$ shifts). When incubating, the adult frequently turned the eggs. Close to the hatching day, females increased their incubation time to 100%. Females were always seen on the eggs at dusk and at dawn, and presumably incubated at night. Males were not usually seen near the nest while females incubated, but they would come quickly when females called.

Of the observed prey delivered to N1 and N2 during incubation ($N = 8$), 37.5% were rodents, 25% lizards, and 37.5% unidentified. All of the prey delivered to the nest or perches nearby during incubation was brought by the males. Females generally (87.5%, $N = 8$) ate the prey at the nest (where males had left the prey after flying directly onto the platform), less frequently she ate the prey at an exchange perch nearby (usually, a large horizontal branch), while the male replaced her at the nest. Feeding rate during incubation averaged 2 times/day (SD = 1.4, range = 1–4, $N = 4$ d). During incubation, nest material was mostly added by the female (Table 2).

Brood-rearing Period. The brood-rearing period was monitored at the eight nests where nestlings

Figure 1. White-throated Hawk egg found in one nest in Challhuaco River Valley, Bariloche, northwestern Argentine Patagonia.

Table 1. Percentage of total daylight time spent by each gender exhibiting various behavior activities through the 2001–02 breeding season at two nests (N1 and N2) of the White-throated Hawk in the Challhuaco River Valley, northwestern Argentine Patagonia. I to VII correspond to observation weeks after hatching. F = females and M = males.

	INCUBATION								NESTLING PERIOD					
	I		II		III		IV		V		VI		VII	
ACTIVITY	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Nest N1														
Incubating	86.8	31.3	93.2	0	0	0	0	0	0	0	0	0	0	0
Attending nest	3.2	0	4.7	0.9	79.0	0	24.6	0	16.3	0	4.2	0	0.63	0
Feeding young	0	0	0	0	2.7	0	1.2	0	0.7	0	1.3	0	0	0
In vicinity	0	4.2	2.1	17.6	6.7	13.0	70.0	10.0	69.0	19.3	62.3	10.9	88.5	3.1
Absent	10.0	64.5	0	81.6	11.8	87.0	4.3	90.1	14.0	80.7	32.2	89.1	10.9	96.9
Nest N2														
Incubating	84.7	9.3	92.2	—	—	—	—	—	—	—	—	—	0	0
Attending nest	1.5	1.4	7.3	0.3	84.9	—	42.4	12.8	19.9	—	3.2	—	0.6	—
Feeding young	—	—	—	—	9.9	—	3.6	—	6.4	—	—	—	—	—
In vicinity	0.9	—	0.4	3.9	1.4	2.7	22.6	7.8	56.6	8.3	77.6	8.7	56.2	8.0
Absent	12.9	89.3	—	95.8	3.8	97.3	31.4	79.4	17.1	91.7	19.2	91.7	43.3	92.1

Table 2. Twig deliveries by White-throated Hawks to nests N1 and N2 during the 2001–02 breeding season in the Challhuaco River Valley, northwestern Argentine Patagonia.

	INCUBATION				NESTLING PERIOD			
	GREEN	DRY	UNIDEN-TIFIED	TOTAL	GREEN	DRY	UNIDEN-TIFIED	TOTAL
Males	1	0	0	1	0	3	0	3
Females	2	0	0	2	18	11	2	31
Unidentified	0	0	1	1	2	1	0	3
Total	3	0	1	4	20	15	2	37

were observed. At nests N1 and N2, this period began on 15–17 December, and extended approximately for 5–6 wk, dates that were comparable to those observed (or inferred) for the other nests. Brood size was one, except for one nest where two chicks were seen during the first week after hatching, but only one was seen thereafter.

At N1 and N2, nestlings were normally brooded by females during the early and late hours of the day (and presumably overnight) until week 4, after which the females probably roosted nearby. Because of the extreme range in daily temperature (5–30°C) during the breeding season in northern Patagonia, the adults (usually the female) varied their postures from sitting tightly and covering the nestling completely to standing over and shading the chick from the sun.

Male visits to the nest were nearly always limited to food deliveries, and his attendance declined during the brood-rearing period (Table 1). Female attendance also diminished through the nestling period, but not as markedly, and she mostly remained in the vicinity of the nest until the juvenile fledged (Table 1). During the last 2 wk of the brood-rearing period, the female visited the nest exclusively to feed the nestling or to deliver prey, and to add and arrange nest material.

Of prey brought to nests N1 and N2 or to the vicinity ($N = 31$), 26% were birds, 16% rodents, 13% lizards, and 45% unidentified. Eighty percent of total prey were brought to nesting areas by the male, 10% by the female, and 10% by an unidentified adult. For 69% of the food deliveries the adult flew directly to the nest with prey, and in 31%, the male flew into the nest vicinity and the female flew to meet him on a perch.

We observed 25 prey deliveries to the nestlings. Chicks were fed by females (84%), males (4%), or consumed the prey by themselves (12%). The mean feeding frequency was 3.22 prey deliveries/day (SD = 1.9, range = 1–6, $N = 10$ d). Food was provided at a mean interval of 4 hr 39 min (SD = 2 hr 4 min, range = 10 min–12 hr 50 min, $N = 11$) and the feeding sessions lasted 10 min (SD = 6.7, $N = 17$), on average. Soon after hatching, chicks could consume morsels, being frequently assisted by the adults (usually the female), who gave them small pieces of meat without skin, feathers or hard body parts. At the age of 4 wk, the chicks attempted to dismember prey by themselves.

No feeding was observed during the week before fledging. Two prey brought by the male at N1 were consumed by the female without sharing them with the nestling. In one of these cases, the prey was carried to the nest, where the nestling tried unsuccessfully to take a piece.

Compared with the incubation period, females at N1 and N2 abruptly increased their nest building activities during the brood-rearing period (Table 2).

At the age of ca. 35 d (ca. 1 wk prior to fledging), when adults were rarely present, the chick moved around the nest and onto nearby limbs to seek shade during hot hours or to bask in the sun during cold hours. Sometimes nestlings moved 3–4 m above and beyond the nest in branches, occasionally hopping and fluttering back to the nest. Also, we heard young calling commonly with subtle chirps, which only sometimes resulted in a response from adults.

Post-fledgling Period. Post-fledgling behavior was described exclusively on incidental observations. Juveniles were always seen with one or two adults (presumably, its parents) flying above the canopy near their nesting territory, or high above adjacent open land. Feeding by juveniles was observed five times in the post-fledgling period. Three times we recorded an adult delivering ro-

Table 3. Characteristics of White-throated Hawk nests and nest trees in northwestern Argentine Patagonia.

	MEAN ± SD (*N*)	RANGE
Height of nest above ground (m)	16.2 ± 3.3 (7)	13.0–22.0
Distance of nest to main tree bole (cm)	0.5 ± 0.9 (7)	0–2.4
Tree height (m)	20.6 ± 3.3 (7)	16.5–25.0
Tree DBH (m)	0.8 ± 0.2 (6)	0.5–1.1
Nest position relative to tree height (%)	78.1 ± 9.7 (7)	95–91

dent prey to a tree perch, then flying off immediately before the juvenile went to the perch to eat. On one occasion we observed an adult passing prey to a juvenile directly in the air. Another time we saw a juvenile eating a rodent (head first) it held in its claws on a perch.

Nests. Three of the 11 occupied (27%) nests were reused in successive breeding seasons. Besides, we found an abandoned and seemingly very old, bulky nest in 2000 that was attributed to White-throated Hawks because of its similarity in appearance and it was located near two confirmed nests (65 and 9 m, respectively). All nests were placed on *Nothofagus* trees, nine in lenga and one in a coihue (*N. dombeyi*). All nests were built in live trees, except one in a mostly dead tree with some few small living branches. The elevation of the nest tree sites averaged 1139 m (SD = 159, range = 924–1350 m, $N = 6$), and slope averaged 21% (SD = 14, range = 4–44, $N = 6$). Nest-tree sites did not show a definite slope orientation, three were facing west, two north, and one south. The number of alternate nests within breeding territories ranged from 1–3, averaging 2 (SD = 0.8, $N = 4$). Mean distance between alternate nests within a territory was 178 m (SD = 118 m, range = 60–310 m, $N = 5$). Distance between occupied nests N1 and N2 was 2 km.

Nests were platforms placed on forked branches in the mid-upper part of, generally, large trees (Table 3). They were firmly secured to the branches, and were almost always hidden from the ground. Materials used for nest building consisted exclusively of twigs and sticks belonging to the species of *Nothofagus* dominant at the site. Dry sticks formed the perimeter of the nests, and green ones lined the inner cup (Fig. 1). Sticks were 0.6–1.4 cm diameter, and 50–70 cm length. Both kinds of twigs (green and dry) were covered by lichen and moss.

Table 4. Morphometrics of White-throated Hawk nests in northwestern Argentine Patagonia. Repeated numbers indicate a nest that was reused during the study period.

NEST	NEST DIAMETER (cm)	CUP DIAMETER (cm)	DEPTH OF NEST CUP (cm)	DEPTH OF NEST (cm)
1	72 × 68	25 × 24	7	26
1	77 × 63	21 × 16	3	37
2	80 × 76	36 × 30	8	22
3	66 × 65	19 × 17	5	45
4	77 × 38	30 × 31	2	22
5	67 × 62	23 × 20	6	37
6	78 × 70	25 × 23	5	30
6	81 × 67	22 × 21	7	40
7	67 × 57	22 × 20	3	24
7	61 × 55	20 × 18	8	32
Means[1]	72.43 × 62.28	25.71 × 23.57	5.14	29.43

[1] Nests reused were included only once; the first measurements were used to calculate means.

Nest platforms were fairly variable in shape, size, height, and orientation with respect to the axis of the nest tree, but most of their remaining features (as architecture) were more or less homogeneous (Table 4). Differences in size, mainly thickness, seem to be mostly related to the age of the nests and number of times they were used. As we believe that the dimensions of preexisting nests impose a constraint on the size of reused nests, we present data on nests separately and did not average dimensions for nests used more than once (Table 4). A nest found under construction in 2001 (not included in Table 4) was noticeably smaller than the average occupied nest, with maximum dimensions 54 × 50 cm. Three nests faced north, two faced southeast and the remaining nests faced east, west, southeast, and northwest. This orientation was not skewed, but our data is insufficient to test for distribution patterns.

DISCUSSION

There is no previous information on the breeding period of the White-throated Hawk, but our data for this species are consistent with the general patterns reported in the literature for other *Buteo* hawks of similar size.

We could not confirm clutch size at the occupied

nests. Regardless of clutch size, overall breeding success, measured in the number of nestlings raised to fledging per successful nest was one, which seems to be relatively low for a *Buteo* in temperate zones (del Hoyo et al. 1994). We elected not to climb nest trees during incubation to avoid disturbing the hawks. The egg found in an abandoned nest is not an accurate clutch size, because we do not know if the clutch had been completed, or had undergone brood reduction. This egg was white, without spots (as egg fragments found at N1). This color pattern is not typical for *Buteo* eggs, which have been described as generally spotted or blotched, on a white or whitish background (Brown and Amadon 1968). However, in some species, as Galápagos (*B. galapagoensis*), Zone-tailed (*B. albonotatus*), and Gurney's (*B. poecilochrous*) hawks, eggs are described as white and unmarked (Brown and Amadon 1968).

Most *Buteo* species nest in trees, but, in certain cases, they also can use cliff ledges or bushes when trees are not available. Occasionally, human structures (e.g., power poles) and nests constructed by other birds (or even squirrels) have been reported as nesting substrates (del Hoyo et al. 1994). Even ground nesting has been observed for the Swainson's Hawk (*B. swainsoni*); (Woffinden and Mosher 1977). All nests we found of the White-throated Hawk were constructed in large southern beech trees, including nests in semi-urban habitats (Gelain et al. 2001). This use of high *Nothofagus* trees was also noted by Pavez (2000) in central Chile. Outside the austral temperate forests of southern Chile and Argentina, there is no information on the nesting biology of this species. Even its breeding distribution and migratory status remain unknown (del Hoyo et al. 1994, Ferguson-Lees and Christie 2001). Consequently, the capability of this species to use other kinds of substrates for nesting is unknown. There is a single report of nesting on a rocky promontory in northern Chile (Goodall et al. 1957, Johnson 1965), but given the characteristics reported, it is unclear if the species was identified correctly.

Almost all *Buteo* hawks line their nests with greenery (del Hoyo et al. 1994). When trees are not available or scarce, hawks use grass, feathers, sedges, moss, small roots, wool, bark, hair, cow or horse dung (del Hoyo et al. 1994). The use of green plant material in bird nests has been suggested to help minimize the harmful effects of ectoparasites (Wimberger 1984), to keep the chicks above the excreta and food remains that are dropped in the nest bowl (Snyder 1975), or as an advertisement to other aerial raptors that the nest is occupied (Newton 1979).

Although the White-throated Hawk appears to be a more abundant raptor than historically reported in Patagonia (Casas and Gelain 1995, Trejo et al. 2001, Gelain et al. 2001), and seems to be rather tolerant to humans during breeding (Gelain et al. 2001), further information is needed on its habitat requirements. Increasing forest loss in Patagonia may negatively affect this species, especially if these forests comprise its primary breeding area.

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